# North Cascades Resource Brief

National Park Service
U.S. Department of the Interior

North Cascades
National Park Complex


**Figure 1.** **Rawhouser measuring water quality on Ross Lake.**

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# Water Quality

The upper Skagit watershed spans the U.S./Canadian border and encompasses 1,018 square miles (2,637 square km). Over the past ten years, an average of 302,940 people a year visit the Ross Lake NRA. This area supports a renowned Rainbow Trout fishery, and it is also home to one of the most protected and robust populations of Bull Trout in the lower United States. These factors combine to make the upper Skagit a unique area supporting exceptional recreational fishing opportunities and the conservation of a Federally Threatened species.

While the majority of the land in the watershed is protected as Park Lands or Wilderness Areas, the aquatic resources in this area still face threats from past and current land-use practices, climate change, as well as the atmospheric deposition and run-off of pollutants. To assess the impacts of these stressors and guide management activities, North Cascades National Park, with support from the Skagit Environmental Endowment Commission (SEEC) and Seattle City Light (SCL), is monitoring the water quality and ecological conditions of Ross Lake and six of the major tributaries in the watershed.

## Monitoring Ross Lake

### Objectives

1. Assess the current water quality conditions and determine the trophic status of Ross Lake.
2. Characterize the seasonal variation of the water quality conditions in Ross Lake.
3. Develop a context for interpreting how the ecological integrity of Ross Lake is responding to fluctuations in nutrients levels, the atmospheric deposition and run-off of pollutants, climate change and introduced non-native species.
4. Determine and verify the long-term trends in the water quality and trophic status of Ross Lake.

### Summary of Activities

In May 2009, four water quality monitoring stations were established at equally spaced locations along the length of Ross Lake (Figures 1 and 2). Each of these stations has been continuously monitoring water temperature at the surface, mid-depth and near the bottom of the lake since that time. In addition to temperature, water chemistry, chlorophyll-a and zooplankton samples are collected at Pumpkin Mountain, Skymo and Little Beaver during the height of biological productivity from April through November. The information generated from these activities will be used to assess nutrient availability, acid neutralizing capacity, trophic status and the ecological condition of the lake. All field operations, laboratory procedures and analysis techniques follow the guidance outlined in the North Coast and Cascade Network Water Quality Monitoring Protocol developed as part of the NPS's Inventory and Monitoring Program.

### 2011 Activities

This is the third year of data collection for SEEC's Ross Lake water quality monitoring project. The commitment to long-term monitoring is beginning to pay off as our understanding of Ross Lake's seasonal cycles increases.

At this time, we have received laboratory results for most of the 2010 water chemistry and zooplankton samples. These results have enabled us to make a preliminary assessment of the trophic status of the reservoir. Temperature data are downloaded annually in November, and this year we will have forty-one months of continuous temperature data.

**Figure 2.** **Locations of water quality monitoring stations in Ross Lake.**


## Preliminary Results and Discussion

These results should be considered preliminary and are not meant to be widely distributed. Our intent is to provide SEEC with a set of initial findings and to keep the commission updated on the activities of this project.

## Water Temperature

Surface water temperatures were much warmer than anticipated. All of the surface water temperature stations regularly recorded daily maximum temperatures above 20°C in July and August. The regulatory criteria for water temperature is measured as the seven-day average of the daily maximum temperature. Water temperatures above 12°C for this criteria are considered too warm to support rearing habitat for native char. While the epilimnion would not generally be expected to provide abundant cold water habitat in the summer, it does appear that temperature may be more of a limiting factor for native char populations than previously thought. We found that water temperatures from late May into November exceeded the 12°C regulatory threshold, and it appears that the majority of the cold water habitat is found in water deeper than 20 m during this time (Figure 3).

## Water Chemistry

One of the primary concerns that initiated the assessment of water quality in Ross Lake was that the availability of nutrients was decreasing as the reservoir aged. The primary evidence for this came from fish population surveys conducted by the Washington Department of Fish and Wildlife. The surveys conducted prior to 2009 indicated that fish size had decreased in the incidence of parasites had increased over time.

Phosphorous in lakes is often the limiting factor in lake productivity. Lakes are considered ultra-oligotrophic, or nutrient poor, with total phosphorous (TP) concentrations <5 µg/L and oligotrophic with concentrations of 5 to 10 µg/L. Oligotrophic lakes are considered to be optimum for supporting salmonid fisheries.

Since the TP concentrations in Ross Lake ranged as high as 8 µg/L it appears that the decrease in fish health may have been unrelated to lake nutrient levels.

Secchi disc transparency (SDT) measurements deeper than 8 m also indicate oligotrophy, and the mean SDT for Ross Lake was 12.6 m. Dissolved oxygen was diffused equally throughout the water column with a mean concentration of 9.5 mg/L. While water temperatures are a concern, these results indicate that Ross Lake is oligotrophic and capable of supporting healthy native fish populations. Laboratory results from the 2011 field season will augment the current data set and provide a more complete picture of seasonal variations.

## Zooplankton

A total of 40 unique taxa were collected from the three stations in Ross Lake. Rotifers, cladocera and copepods contributed 70, 24 and 6% of the organisms, respectively.

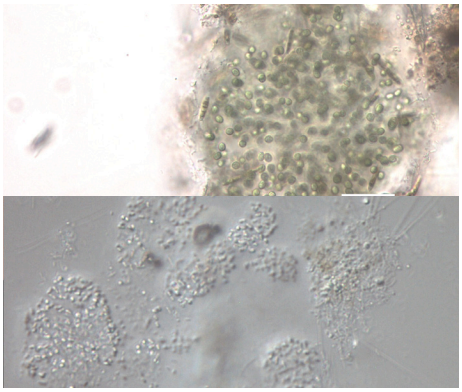

**Figure 4.** **Photographs of Aphanocapsa and Aphanothece found in samples collected from Ross Lake. (Photo Credit: Robin Mathews)**

Results from the zooplankton tows provided some of the most interesting insights into the condition of Ross Lake. The zooplankton samples collected for this project used a 64-µm mesh net. This mesh size was selected because it is small enough to capture the largest zooplankton while allowing the smaller, often single-celled organisms and phytoplankton; to pass through. However, the samples collected in 2009 were filled with an unusually dense algae bloom that developed in the summer of 2009 and 2010, and this bloom clogged the collection net and lab equipment used to process the samples. To help determine the source of the clogging supplemental plankton tows were collected and sent to Dr. Robin Matthews at Western Washington University for analysis. Initial results indicate that the source of the clogging is likely coming from two genera of cyanobacteria (blue-green algae): referred to as Aphanocapsa and Aphanothece (Figure 4). At this time, the

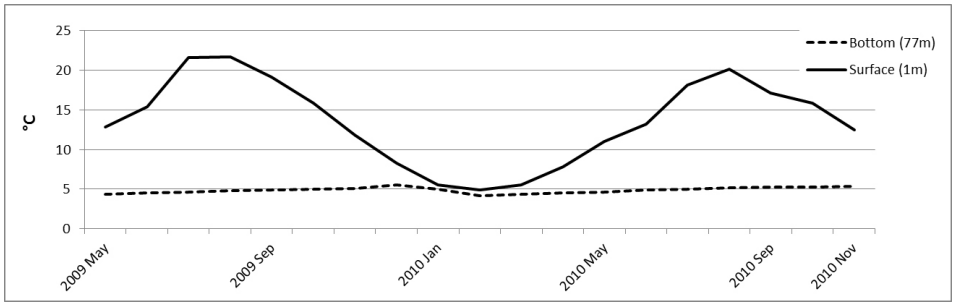


**Figure 3.** **Plot of continuous temperature data from the Big Beaver water quality station for the seven day average of the daily maximum temperature.**

implications of these taxa on the water quality in Ross Lake is uncertain and zooplankton samples collected in 2011 did not appear to have the same concentrations of Aphanocapsa and Aphanothece as the previous two years.

## Monitoring Ross Lake Tributaries

### Project Objectives

1. Determine status and trends of the water quality and ecological integrity for the major tributaries draining into Ross Lake.

2. Identify specific land management activities affecting the water quality of the streams draining into Ross Lake.

### Objectives for 2011

1. Conduct annual monitoring at each sample location to collect benthic macroinvertebrate samples, download continuous water and air temperature data, conduct maintenance of air and water temperature stations and collect water chemistry samples.

2. Validate and enter data collected during 2011. Implement standard quality control practices. Process and evaluate data, comparing it to previous results to identify changes and assess trends.

### Summary of 2011 Activities

### 2011 Field Sampling

All six of Ross Lake's major tributaries were sampled in September of 2011, and all temperature stations yielded information provided.

Water and air temperature data were downloaded from all temperature stations, and data loggers were replaced. Temperature station hardware was checked and replaced as necessary.

Four benthic macroinvertebrate samples were collected from riffle habitats in each of the six tributaries. These samples will be used to assess the ecological integrity of the tributaries being monitored.

Data characterizing in-stream conditions and riparian habitat were collected for all six tributary sites. Water quality parameters collected at all six tributaries include: pH, DO, conductivity, water clarity, water odor, sediment odor and surface films.

### Data Management

Continuous temperature data were validated and an initial evaluation has been conducted. Data loggers were tested for post-deployment calibration and for quality control purposes.

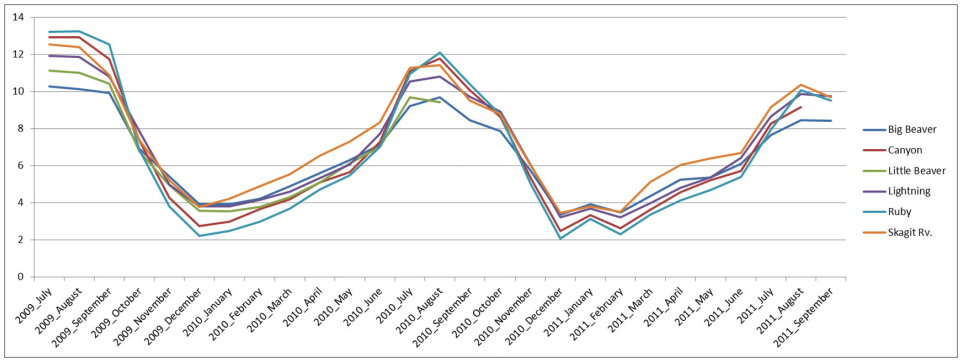


**Figure 5.** **A comparison of maximum 7-day average temperature for all six tributaries monitored as part of the SEEC water quality project. Water temperatures exceeding 12°C exceed Washington State regulatory criteria for supporting native char rearing habitat.**

**Figure 6.** **Little Beaver Creek was visited and sampled for three consecutive years.**

All contracted analyses and data concerning 2010 Ross Lake tributary samples have been completed and received. Processing and evaluation of 2011 data is ongoing. Benthic macroinvertebrate samples are currently being processed by the contracted lab. Data are expected early in 2012.

### Notes of Interest

The USFS completed the removal and capping of contaminated mine tailings as part of the Azurite Mine CERCLA cleanup. USFS will continue monitoring stream sediments and water quality at the cleanup site into the foreseeable future.

Major construction was conducted in Cabinet Creek on USFS lands to stabilize Highway 20. During construction, Cabinet Creek was diverted and the entire stream channel was cleared below the road to Ruby Creek.

SEEC-funded monitoring will play an important role to determine if these activities are impacting Ruby and Canyon Creeks.